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ABSTRACT

The effects of distraction on achievement are particularly important in relation to the acceptability of computer-assisted instructional materials. In addition to these effects, various levels of anxiety may also be deleterious to the learner. In order to measure the effects of both distraction and anxiety 121 subjects were used in a two-by-two design experiment, defined on one hand by distraction and non-distraction conditions, and on the other by constructing responses as opposed to reading the program. Using multiple linear regression analysis the effects of the conditions and their interactions with test anxiety were determined. The only significant effect on instruction was that constructing responses led to higher achievement than only reading the material. State anxiety was higher for all groups in which an overt response was required. The findings suggest that decrements in achievement attributable to distraction are more accurately interpreted in motivation terms. (Author/MC)

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DISTRACTION, RESPONSE MODE, ANXIETY, AND ACHIEVEMENT IN CAI

Sigmund Tobias

Tech Memo No. 52
June 30, 1972
Tallahassee, Florida

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Distraction, Response Mode, Anxiety, and Achievement in CAI

Sigmund Tobias
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ABSTRACT

In this investigation the effects of distraction, mode of responding to CAI material, and anxiety were studied, as was the interaction among these variables. A total of 121 subjects were used in a two-by-two design, defined by a distraction and non-distraction condition, and constructing responses as opposed to reading the program. The effects of these conditions and their interactions with test anxiety were determined by multiple linear regression analysis. Finally, the effect of these conditions on state anxiety was assessed at four points in the instructional and test sequence. The only significant effect on instruction was that constructing responses led to higher achievement than only reading the material. State anxiety was higher for all groups in which an overt response was required. The findings suggest that decrements in achievement attributable to distraction are more accurately interpreted in motivation terms.

Distraction, Response Mode, Anxiety, and Achievement in CAI

Sigmund Tobias
Florida State University

The effect of distraction on achievement in learning situations is a topic of obvious importance to education. Instructors and students frequently explain poor performance by suggesting that distractions of one kind or another interfered with their learning. It seems so reasonable to assume that individuals who are exposed to distraction while studying achieve less than other students, that it is surprising to find little support for such an effect in the educational research literature. The first purpose of the present research was, thus, to clarify the effect of distraction on achievement in a learning situation.

A second purpose of the present experiment was to clarify some discrepancies in research findings on the effect of response mode. Some studies using technical materials dealing with heart disease in a programmed instruction format had shown that constructing responses and receiving feedback led to superior achievement than reading the program; other studies conducted with these materials in a CAI context had failed to replicate these findings. The second purpose of the present investigation was, therefore, to study this discrepancy in findings. Furthermore, there appeared to be a sound rationale for expecting an interaction between distraction and response mode. An instructional strategy in which subjects were required to respond overtly and receive feedback regarding their responses should suffer less from periodic diversion of

student attention than one in which responding and feedback were absent. Presumably, making a response and receiving feedback could make up for important elements missed while the student's attention was diverted from the task at hand.

A third concern of the present research was the possible interaction between test anxiety and distraction, and the effect of response mode on state anxiety. The rationale and research relating to these purposes are presented below.

Distraction

Two investigations on the effects of distraction on learning by college achievers and underachievers were reported by Baker and Maddell (1965a,b). In the first study underachievers took more time than achievers to complete arithmetic computations when distraction was introduced in the form of humorous conversation provided by a comedy record. There was no achievement difference among the groups, nor was the distraction effect significant when interference was provided by shop noises or orally presented arithmetic computations. In the second investigation Baker and Maddell (1965b) found clear-cut achievement differences between freshmen achievers and underachievers. Achievement for both groups was impaired by the distracting stimuli; the effect for the underachieving group being larger.

Mandell (1966) studied the effects of generalized auditory distraction on the performance of elementary school subjects on the Stroop Color-Word Test. Auditory distractors consisted of recorded playground noises. Differences between the distraction and control groups were

significant only for one of four grades represented in the sample. Slater (1968) studied the effects of noise on achievement with seventh grade pupils. She found that different kinds of experimentally-manipulated noises had virtually no effect on achievement. Noise was created by playing recordings through the school speaker system, and by creating noise in school corridors.

Tobias (1969) studied the interaction between distraction and achievement from programmed instruction. Two groups were exposed to a program while wearing earphones through which a tape recording was played. The tape contained a large variety of programmed material, including musical excerpts, speeches, readings from technical manuals, children singing, and a small amount of material from comedy recordings. Students wore the earphones while working on the instructional material, though not while working on a posttest which was subsequently presented. No achievement differences attributable to distraction were found on program indices or on posttests.

Harries (1970) examined the effects of test anxiety and different types of distraction on the performance of sixth grade students on the Metropolitan Achievement Test. He employed conditions of visual distraction, auditory distraction, visual and auditory distraction combined, in addition to a minimal distraction and a standard test instructions condition. The results indicated a main effect for both distraction and anxiety; however, there was no interaction among these variables. Selected post hoc comparisons between the high and low anxiety groups in the distraction conditions found significant differences between these. A

similar comparison between the groups under conditions of no distraction yielded no significant differences.

With the exception of the Harries (1970) study, the only clear-cut distraction effect demonstrated in these investigations was that by Baker and Maddell (1956b). In that investigation the distracting stimulus was a comedy recording. The construct of distraction implies that a student's attention is diverted from a task which is of primary importance to a task of lesser importance. In the experiment by Baker and Maddell the attractiveness of the distracting comedy material compared to the routine learning task, arithmetic addition problems, or reading comprehension, conceivably inverted this order of importance from the student's point of view. It is thus difficult to ascertain whether Baker and Maddell's results can be attributed to distraction as presently discussed.

In most of the other investigations dealing with the effects of distraction in educationally relevant situations, there appeared to be no evidence supporting the intuitively obvious conception that a person's performance on the task should suffer when he is distracted by a competing task. One reason for this lack of significant finding may lie in the way distraction was implemented in these investigations. Distracting stimuli were presented to students without assuring that their attention was in fact diverted from the primary learning task. Since students are raised in an environment in which a variety of stimuli continually compete for their attention, it seems likely that in these distractions students were able to screen out the distracting stimuli; hence they were <u>not</u> distracted. It seemed important to assure the diversion of student attention in order to study the effects of distraction. These considerations led to the

formulation of an experimental paradigm in which students were required to engage in high-order processing involved in the acquisition of meaningful learning material while simultaneously required to store in short-term memory nonsense syllables which they were periodically asked to recall. Such a paradigm was intended to assure that students would in fact be forced to shift their attention from one task to the other, and the accuracy of their recall of the nonsense syllables would be a measure of the effectiveness of the diverting task.

Response Mode

One of the important features of both programmed instruction (PI) and computer-assisted instruction (CAI) is the fact that the students respond to the instructional material, and receive feedback regarding the accuracy of the responses. Students can respond to programs in a number of ways: In the constructed response mode, students construct an answer to a question or complete a blank in the text. In the multiple choice mode, an answer is selected from one of a variety of alternatives. In the covert response mode, students "think" an answer without overtly making it; and in the reading mode, students read the program recast in the form of completed sentences without making overt responses of any kind.

A number of early investigations of the response mode issue, reviewed by Anderson (1969), revealed that no significant achievement differences among response modes was a typical finding. These results were attributed to the poor quality of the programs employed in these investigations. Holland (1967) indicated that many of the programs employed in these investigations had very high "blackout ratios," that is,

large percentages of the text could be blacked out without altering the percentage of incorrect responses students made to the program. This finding suggested that responding overtly to programs could not be expected to alter achievement significantly since making the correct program response was not highly related to processing content introduced in the frames. Material with low blackout ratios, Holland suggested, typically yielded findings in favor of the constructed response mode.

An alternate formulation regarding the response mode issue was advanced stressing the subject's prior familiarity with the subject matter (Tobias, 1972a). This interpretation suggested that for content with which individuals had a good deal of previous experience, in the sense of knowing the responses required by the subject matter, little difference was to be expected among different modes of responding to the program. On the other hand, for subject matter with which the students had little prior familiarity, in the sense of having the responses required by the program in the repertory, responding overtly and receiving feedback for it was expected to lead to higher achievement. A series of investigations, summarized elsewhere (Tobias, 1972a), using programs containing both relatively familiar material and content with which students had little familiarity confirmed the familiarity interpretation. The fact that both programs were drawn from the same domain, the area of heart disease, and had relatively low blackout ratios appeared to strengthen the familiarity interpretation.

The familiarity hypotheses was derived from a series of studies using PI materials. When the heart disease program was first adapted for

presentation via the IBM 1500 CAI system the PI findings regarding the superiority of the constructed response mode were not replicated (Leherissey, et al., 1971, 1972). Analysis of the CAI version of the heart disease program suggested that in an attempt to replicate findings derived from PI materials, the CAI program duplicated as far as was possible the manner in which the materials were presented in the PI format. Differences in the CAI medium, however, appeared to have altered the CAI version substantially from what it had been in the programmed format. A detailed description of the modifications made to the program and the history of the heart disease program is available elsewhere (Tobias, 1972b). The second purpose of the present investigation was, therefore, to examine the discrepancy between PI and CAI findings with respect to the response mode issue.

Anxiety

There is a compelling rationale suggesting that high anxiety (HA) students should profit more from the instructional support offered in CAI and PI than low anxiety (LA) individuals. The reduced level of difficulty of such programmed materials, the more effective organization of the content, and the reduction of the student's uncertainty while studying the materials would suggest that these instructional modes ought to be especially beneficial for the performance of HA individuals. An attribute treatment interaction, ATI, (Tobias, 1970) is thus suggested in which anxiety serves as the attribute and different manipulations of the program serve as alternate instructional treatments.

The research relating anxiety to differences in response modes has sometimes reported small main effects attributable to anxiety; the predicted interactions have, however, generally not been reported (Tobias & Abramson, 1971).

The effect of test anxiety on performance have recently been reviewed by Sarason (1972) and by Wine (1971). These reviews have indicated that in studies varying the difficulty of the subject matter, and the intensity of evaluative stress, the performance of HA students is typically poor compared to that of LA individuals. Wine has suggested that the direction of attention may be the mechanism accounting for this performance difference. Wine indicates that HA students focus a greater proportion of their attention on personal concerns, such as feelings of negative self regard and somatic preoccupations, than LA individuals. Students in the latter category, on the other hand, focus less of their attention on personal concerns and a greater proportion of their attention to task relevant considerations. For these reasons it was expected in the present investigation that under conditions of distraction test anxiety ought to interact with distraction such that the attention of HA students should be disrupted to a greater degree in their performance on the instructional task compared to that of less anxious individuals. It was reasoned that under conditions of distraction HA students would have to divide their attention between the distraction condition, personally relevant concerns and task variables; less anxious individuals, on the other hand, ought to be able to devote a greater proportion of their attention to task relevant concerns and hence achieve more. Furthermore, it was expected that the distraction condition would increase the difficulty levels of the material to such a degree that anxiety would be aroused and maintained to a greater degree under conditions of distraction than under the neutral conditions.

Anxiety and response mode. Previous CAI research in which state anxiety was assessed while students were working on the instructional materials have typically indicated higher levels of anxiety for constructing responses compared to reading the program cast in the form of completed sentences (Leherissey, et al., 1971a; Leherissey et al., 1971b). This was a somewhat surprising finding since the constructed response mode had been envisioned as providing greater instructional support, less uncertainty, and more specific reinforcement compared to the reading mode. A further purpose of the present investigation was, therefore, to investigate differences in state anxiety attributable to response mode and distracting conditions with the revised instructional materials employed in the present investigation.

Method

This experiment consisted of a 2 x 2 research design. Subjects were randomly assigned to work the instructional program under neutral or distraction conditions, and within each group, random assignment was made to either the constructed response mode with feedback, or distraction conditions. Interactions between the manipulated variables and anxiety were assessed by multiple linear regression analysis.

Procedure

The procedures were administered in the following sequence:

1. A pre-task period during which students responded to the task anxiety scale (TAS; Sarason, 1972), and the A-Trait scale of the State-Trait Anxiety Inventory (Spielberger, et al., 1970). At the end of

this period subjects were familiarized with the operations of the IBM 1500 instructional system, and signed on to the cathode ray terminal.

2. An instructional period. In this phase of the experiment, the students worked the instructional program in the condition to which they had been randomly assigned. The brief five item version of the A-State scale (Spielberger, et al., 1970) was administered to the students at four points in the instructional sequence: immediately prior to the beginning of the program, at the mid-point of the program, immediately following the last program frame, and immediately after the posttest. The A-State scales were presented on terminal.

3. A posttest period. During this phase subjects took an on-terminal posttest on the content of the program. A 14-item Likert type, attitude scale was administered at the end of the posttest. The attitude scale was presented off terminal at the end of the posttest. A copy of that scale is included in Appendix A. Finally, subjects who were in the distraction conditon were asked to recall the CVC programs after completing the attitude scale.

Distraction

Distraction was implemented by requiring students to memorize CVC syllables while working on the program. The syllables were drawn from Noble's (1961) list, and consisted of 35 trigrams randomly selected from the group with meaningfulness values (m') between 2.52 and 2.73 (Noble, 1961, p-519). The trigrams were inserted, in random order, prior to the beginning of a frame, and then flashed onto the cathode ray screen for three seconds. Recall was requested after 1, 2, or 3 frames, again

determined by random order. When the student response was an incorrect syllable, he was asked to respond again. After the second trial the next syllable was presented whether the response was correct or not. The syllables were presented, and recall requested at the same point in both the reading and constructed response programs. Since the structure of the reading program was somewhat different, in view of the fact that responses to the program were not solicited, the reading version contained one less syllable. The list of syllables used in both conditions appears in Appendix A. The CVC syllables appeared on the center of the CRT screen for three seconds and were replaced by the next program frame. Subjects in the distracting condition were informed that the purpose of the experiment was to study how well they could do two different things at the same time.

Materials

The instructional materials consisted of a revised version of an instructional program dealing with the diagnosis of myocardial infarction from the fifth precordial lead of the electrocardiogram. Details regarding the history and revisions of this program are presented elsewhere (Tobias, 1972b). The materials used in this experiment consisted of an abbreviated version of the technical section of this program, dealing with the technical terminology regarding severity of heart disease, different degrees of coronary damage, and their reversibility. The program contained both verbal responses and graphic answers requiring drawings of different types of ECG tracings characteristic of various levels of heart disease, and graphic representations of the type and

severity of damage suffered by the heart muscle. On the IBM 1500 system drawings were created by keying different sections of the ECG tracings to 10 digits. The subjects could thus "draw" the normal ECG tracings by typing the numbers 1, 6, 3, 4, 2. Following each of these numbers the segment of the ECG tracing associated with that digit was displayed on the CRT screen. Subjects could change the tracings created by erasing all of it and beginning anew.

In the constructed response version one or several answers were required for each frame. After an answer was entered, the system processed it and presented three kinds of feedback: (a) that the answer was correct, and identical to the textbook answer which was then presented, (b) that the answer appeared equivalent to the textbook answer, which was then presented, (c) that the answer appeared different from the textbook answer which then was presented. On frames requiring more than one response, each answer was processed separately and feedback provided before the sections of the frame requiring further answers were displayed.

The reading version of the program had been altered to require no overt responses of any kind. Blanks were filled in, and sentences ending in a question were rephrased in rhetorical form. Subjects signified that they were ready for the next frame by pressing the space bar. With these exceptions, the reading version was identical to the constructed response version. In the distraction condition, reading subjects responded overtly only to the distraction stimuli.

Posttest

A posttest requiring constructed responses was administered on terminal immediately after the conclusion of the program. The posttest

was a revised version of that originally used with this program (Tobias, 1968). The alpha reliability of the posttest was .81.

The attitude scale administered at the conclusion of the program consisted of a 14-item Likert type scale dealing with the students' feelings about the content and presentation of the instructional material. The alpha reliability of this scale (appearing in Appendix B) was determined to be .82 for the present sample.

Subjects

The original subject pool consisted of 124 students. Three subjects were unable to complete the instructional sequence yielding a final subject pool of 121. Students were recruited from the general psychology course at Florida State University, which included a requirement for participation in research in order for the students to successfully complete the psychology course.

Results

The major results of this investigation dealt with the effects of distraction, response mode, and test anxiety on achievement in the posttest. Table 1 presents means of standard deviations on these and other variables for all groups.

The data were analyzed using multiple linear regression techniques (Cohen, 1968). Subject's group membership in the distraction and response mode conditions were represented by binary vectors and anxiety was represented as a continuous vector by the TAS score. Interaction vectors were formed by cross multiplying the components vectors.

TABLE 1

Means and SDs for All Groups

on Selected Variables

	Distraction				Nondistraction			
	CR		Reading		CR		Reading	
	M	SD	M	SD	M	SD	M	SD
Posttest[1]	45.4	8.1	32.7	10.1	46.3	5.8	36.2	8.3
Program Time[2]	66.3	16.8	27.4	6.5	64.6	10.8	20.1	5.5
Attitude	37.0	6.4	37.9	7.4	37.5	7.0	42.1	5.5
TAS	16.0	6.6	16.2	5.3	18.6	7.2	17.1	7.8
Program Correct[3]	199.5	23.0			199.0	24.5		
CVC Correct Trial I	.81	.12	.89	.09				
CVC Wrong	.16	.12	.10	.09				
CVC Recall	28.5	11.5	27.5	11.8				
N	31		30		29		31	

[1]Total number of points = 61

[2]In minutes.

[3]Total number of points = 250

The initial analysis sought to determine whether there were sex interactions with anxiety. No evidence of such interactions were found. The succeeding analysis followed a step-down procedure similar to the one described by Cohen (1968). The significance of main effects was tested by forming a reduced model containing all the main effects and testing for the significance of each variable by dropping that vector from the model, and then testing for the significance of the reduction in the multiple correlation coefficient. This procedure allows for the estimation of the percentage of variance contributed uniquely by any variable adjusted for the effects of all others. The second modification of the step-down procedure was to employ the full model, containing all the vectors, in the denominator rather than only the previous restricted models. This procedure resulted in a more conservative test than is usually recommended. Interaction effects were tested for significance by adding vectors in the order in which they appear in Table 2, and the significance tested by comparing them to the prior model and dividing with the full model in the denominator.

The results indicate that, contrary to predictions, distraction did not have a significant effect on achievement. Even though the means were in the predicted direction, as can be determined from Table 1, the F test failed of significance at the 5% level, its exact probability being .09. Regression analysis indicated that the response mode variable had a large effect on the results, accounting for 33% of the achievement variance, significant beyond the .001 level.

Analysis of the time data indicated that the distraction had small, but significant effect, the groups in the distraction condition

TABLE 2

Percent of Variance Accounted, and *F* Test Results from Regression Analysis[1]

Variables	Posttest		Time		Attitude	
	Variance	*F*	Variance	*F*	Variance	*F*
Distraction (D)	2	2.81	1	5.02*	3	3.56[2]
Response Mode (R)	33	60.08**	78	431.38**	4	5.57*
Test Anxiety (A)	1	1.78				
D X R	1	1.21			3	1.78
D X A	1	2.20			3	3.78[3]
R X A						
D X R X A	1	1.68				

* $p < .05$

** $p < .001$

[1] *F* values of less than 1 not shown.

[2] $p = .056$

[3] $p = .051$

taking slightly longer to complete the program. As expected, response mode had a very large effect on time on program, accounting for 78% of the variance being significant well beyond the .001 level. Table 1 indicates that the constructed response group took about twice as much time to complete the program compared to the reading group.

The results indicate that the differences in attitude attributable to the distraction conditions were of borderline significance. Table 1 indicates that the attitudes of the distraction group were slightly less positive than those of the regular group. In terms of response modes, the results indicated that reading led to more positive attitudes towards materials than the constructed response mode.

State Anxiety Data

The brief five item version of the A-State Anxiety questionnaire was administered at four points: prior to the beginning of the program, halfway through the program, at the end of the program, and at the end of the posttest. The means for the four administrations of the A-State by distraction response mode condition are reproduced in Table 3.

TABLE 3

A-State Means by Conditions

A-State	Distraction		Non-Distraction	
	CR	Reading	CR	Reading
Pre-Program	9.2	10.1	10.3	9.7
Mid-Program	10.2	10.4	9.9	8.5
After-Program	10.5	10.5	11.7	7.7
After-Test	11.6	11.2	10.7	10.6

A 2 x 2 x 4 analysis of variance with repeated measures on the last factor was computed on these data to determine the significance of the differences in A-State. These results shown in Table 4 indicate that

TABLE 4

Repeated Measures ANOVA of A-States

Source Between Ss	df	MS	F
Distraction (A)	1	44.07	1.36
Response Mode (B)	1	54.48	1.69
A x B	1	87.07	2.70
Error	112	32.32	
Within Ss			
A-State (C)	3	38.89	4.87**
A x C	3	11.83	1.48
B x C	3	24.87	3.12*
A x B x C	3	23.01	2.88*
Error	336	7.98	

* $p < .05$

** $p < .01$

neither distraction, nor response mode, nor the interaction among them led to significant differences in A-State. There were, however, highly significant differences among the four A-State measures, as indicated in Table 4.

A Newman-Keulls comparison of means indicated for all groups combined, the A-State obtained after the posttest, on which subjects were instructed to indicate how they felt during the posttest, was significantly higher than any of the other A-State measures. There were also two significant interactions between the A-States and response modes, and a triple interaction between distraction, response mode, and the four A-State measures. A plot of this data, shown in Figure 1, on the succeeding page, suggests that these interactions can be largely attributed to the performance of the reading group under the nondistraction conditions. The second and third A-State scores for these groups are much below those of any of the other groups, though the A-State obtained after posttest rises approximately to the level of the others.

Discussion

The major results of this experiment failed to find a main effect attributable to the distraction, even though the means were in the predicted direction. The results replicated the superiority of the constructed response mode obtained in investigations using the same instructional material in a programmed instruction format, though this group took approximately twice the time taken by the reading groups. There were no interactions with test anxiety. Finally, although there were no main effects attributable to response mode on state anxiety, all the conditions in which responses were made had higher state anxiety during instruction than the one group making no responses. The implications of these results will be discussed below.

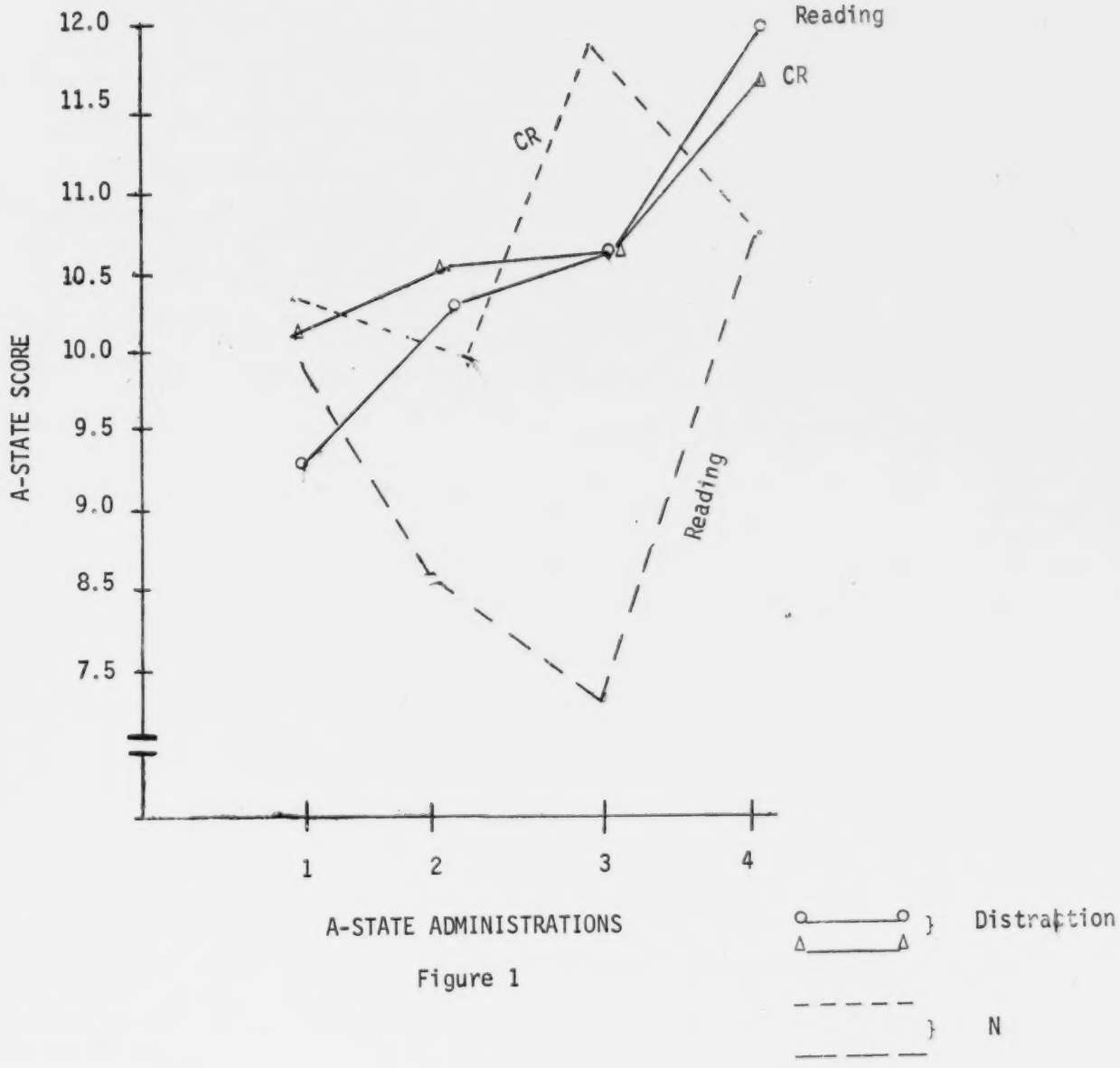
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
7.5
A-STATE SCORE
Reading
CR
CR
Reading
1
2
3
4
A-STATE ADMINISTRATIONS
Distraction
N

Figure 1

Distraction

Both the present investigation, as well as a number of previous studies have failed to find a decrement in achievement which could be attributed to distraction. Prior to this investigation it had been reasoned that inconsistencies in research findings on the effect of distraction in educationally relevant situation could be attributed to the fact that while a distraction condition had been implemented, it had not been ascertained that the attention of students was actually diverted while working on the instructional task. In the present investigation there is evidence that such diversion of attention in fact did occur. Students recalled an average of 85% of the trigrams correctly while working on the instructional program, and an average of 81% of the trigrams were recalled after the posttest and attitude questionnaire were administered. The findings of no differences in posttest performance between the distraction and nondistraction groups, and the fact that the number of correct responses to the program by the constructed response distraction and nondistraction groups did not differ, indicates that the students were able to process the instructional task effectively as well.

The model for implementing distraction in this investigation was to assure that students would be forced to divert their attention from the program task to memorizing the CVC syllables. It was felt that in the process of memorizing these syllables students would have to refresh short-term memory often enough by switching from one task to the other repeatedly. The accurate performance on the CVC task indicates that some of this switching must, indeed, have occurred. The fact that

the switching of attention did not constitute a serious obstacle to their achievement from the program clearly suggests that students have a much greater ability for serial processing of different types of stimulus input than had been expected. Distraction exerted a nonsignificant effect in this investigation, though presumably with a somewhat larger sample significance would have been obtained. Nevertheless, regression analysis indicated that even had the results been statistically significant, the total percentage of variance accounted for by distraction is in the area of 2%. When this is compared to the 33% of variance accounted for by the response mode, it becomes clear that the distraction effect is of relatively small magnitude.

The results of distraction investigations call into question the educational truism that students don't learn because they are distracted. It is suggested that students can switch their attention quite rapidly from one task to another, and learn both effectively - at least for periods similar to those used in this study. The results of Baker and Mabell (1965a,b) suggest that when the motivational value of the distracting stimuli is very much higher than that of the learning task, a distraction effect can be achieved. The educational relevance of this finding would seem to be that distraction affects achievement when the distracting stimuli are less boring, more entertaining, and more motivating than the instructional material. These findings suggest that the problem of distraction interfering in pupil learning is not one of student ability to process different inputs at one time, but instead a problem of which type of input is more motivating or less boring.

Response Mode

The results with respect to response mode replicate prior findings in programmed instruction that constructing responses leads to superior achievement on content like the present with which students have little prior familiarity. The discrepancies in findings between previous CAI studies (Leherissey et al., 1971a; Leherissey et al., 1972b) using this program, and present data, as well as results from programmed instruction, were apparently attributable to modifications made to this version of the program. These included improving the quality of feedback presented to students, clearer frame organization, and administering the posttest on terminal. The section of the program dealing with familiar material was not used in this study, one cannot, therefore, conclude from this investigation that constructed responding leads to superior achievement only in areas areas prior familiarity is lacking. Nevertheless, the previous interpretation (Tobias, 1972a) that for this kind of subject matter overt responding led to superior achievement is strengthened.

Response Mode and State Anxiety. In prior studies state anxiety levels for different response modes varied. In this study, the ANOVA revealed no main effects attributable to response mode. However, as indicated in Figure 1, the reading group in the nondistraction condition had lower levels of state anxiety than any of the other groups. This group was the only one which did not require students to make any responses which were evaluated by the CAI system. Both constructed response groups made answers to the instructional program, and the adequacy of these responses was evaluated by the system. In the reading-distraction group,

students did not respond to the instructional material, however, they did respond to the nonsense syllables and those answers were evaluated for correctness. Apparently, any evaluation of responses was viewed as a situation of some evaluative stress by students. This perception is apparently sufficient to increment levels of state anxiety slightly.

If the interpretation that providing students with feedback regarding the accuracy of their responses raises state anxiety is correct, instructional designers are in an ironic position. Eliciting responses, and evaluating these is seen as a condition of maximal instructional support. Simultaneously, however, evaluation of responses appears to increase the students' perception of evaluative stress, make them view the situation as test-like rather than instructional in character, and raises state anxiety slightly. This hypothesis is strengthened by the frequent observation that students refer to constructed response versions of a program as a test. An interesting question for further research is whether students can be taught to view feedback offered by CAI, or any other instructional strategy, at a purely cognitive level divorced from connotations of negative evaluation.

Time

The constructed response mode took about twice as much time compared to the group reading the material cast in the form of completed sentences. An interesting question is posed by these results. Is the increment in achievement observed in the present and previous investigations attributable to overt responding and reinforcement, or to the fact that students take approximately twice the time to master the material as the students in the reading mode? This question is similar

to that raised by Carver (1971) regarding mathemagenic behaviors, and previously raised by Carrol (1963). Carrol suggested that, all other things being equal, time was the critical variable in instruction. The hypothesis suggested by the present results is that the increment in achievement observed for the constructed response group may well be attributable to the additional time on task taken. When time was covaried by regression techniques, the highly significant effect attributable to response mode was no longer significant. The covariance analysis results suggest that a worthwhile hypothesis to be explored in future investigations is that any method which induces students to spend greater amounts of time studying than they ordinarily would may well result in superior achievement. The question raised by these results is that it may not be the overt responding, nor the quality of feedback, nor the technological expertise evident in this CAI version of the program which resulted in higher achievement, but instead simply the amount of time students were forced to spend attending to the instructional materials.

The present analysis regarding the importance of time on task is similar to Anderson's (1971) hypothesis that the critical variable in the effects of different instructional methods is the degree to which students are forced to attend to the instructional content. In the present investigation, the constructed response mode forced the learner to attend to the program for longer periods of time. This increased attention appeared to have resulted in superior achievement. If strategies could be invented which compelled students to spend greater amounts of time studying the instructional material which are less expensive to construct than computer-assisted instruction, similar increments achievement might be observed. It is this hypothesis which deserves future exploration.

Anxiety

Present results indicated no main effect or interaction attributable to test anxiety. These data contrast with the body of research summarized by Wine (1971) and by Sarason (1972) dealing with test anxiety. These reviewers reported that typically HA students achieve less than LA students. It has been observed elsewhere (Tobias & Abramson, 1971) that difficulty of subject matter may well be a critical variable in the degree to which anxiety is engaged and maintained within the instructional situation. Apparently, in order for anxiety to exercise debilitating effects relatively difficult subject matter is required (Sarason, 1972; Tobias, et al., 1972; Sarason & Palola, 1960).

The question raised by these results is whether anxiety is a variable with useful explanatory power in instructional contexts in which the error rate is relatively low. Specifically, does anxiety account for important amounts of variance in investigations where error rates are relatively low, such as programmed instruction, computer-assisted instruction, and individualized instruction? The results of previous research on this question suggests that in those situations the effect is relatively small.

In individualized instructional contexts an attempt is made to minimize the difficulty of the material in order to have a high ratio of success for most students. It appears likely from the present results, and those observed in other investigations in the area of programmed instruction (Tobias & Abramson, 1971; Tobias, 1972c) that anxiety may well be of limited importance in such contexts. The low level of difficulty of the instructional material, high level of certainty with respect to correctness of responses, and tight organization of the content

may limit the debilitating effects of anxiety. Even when the instructional materials are experimentally altered in order to increase their difficulty, apparently, these alterations are not sufficient to both evoke and maintain high levels of anxiety sufficient to exert significant debilitating effects on achievement. It may well be, therefore, that anxiety is a useful construct in other areas, but has limited utility in the area of individualized instruction.

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Appendix A

List of alphabetized nonsense syllables

BIM
BIS
COK
DAS
DOK
DUL
FES
FUD
GAV
GEY
HED
HEK
HIR
HUP
JEF
JEP
JOV
KAL
KAP
LEX
LOD
MUC
MUG
NAS*
NEB
NEK
NYL
PEC
PUL
RIL
RUL
TIK
TOK
VAS
WEP
YUL

* Extra syllable not in reading condition.

APPENDIX B

ATTITUDE SCALE

Please answer the following questions in terms of how you feel about the program you have just completed. Indicate your feeling by marking on the enclosed IBM answer sheet the choice which most accurately reflects your opinion.

1. How did you feel about the way the material was presented?

1	2	3	4
Enjoyed presentation	Presentation moderately pleasant	Presentation moderately unpleasant	Disliked presentation

2. Did you find yourself just trying to get through the material, rather than trying to learn?

1	2	3	4
All the time	Most of the time	Some of the time	Never

3. Did you know whether your answers were correct without checking them?

1	2	3	4
All the time	Most of the time	Some of the time	Never

	Definitely 1	Probably 2	Probably not 3	Definitely not 4
4. Would you like to learn other subjects by the same format?				
5. Did you feel that this format made it <u>harder</u> for you to learn the subject?				
6. Do you feel that this format helped you learn the material more <u>rapidly</u> than you would have learned it from a non-computer format?				
7. Did you feel that the format made it <u>more difficult</u> for you to concentrate on the material than a non-computer format?				

	Definitely 1	Probably 2	Probably not 3	Definitely not 4
8. Did you feel more certain about knowing the subject matter than you would have if it were not presented by computer?				
9. Did you feel that this format made learning more mechanical?				
10. Would you like to learn more about computer-assisted instruction?				
11. Would you like to learn more about interpreting ECG tracings?				
12. Would you like to learn more about degree of damage to the heart?				
13. Would you like to learn more about medical terminology related to heart disease?				
14. Would you like to learn more about the effects of damage on the heart muscle, as represented in the program by the drawings with shading?				

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